# Leveraging AI for Effective Teaching: A Machine Learning Approach to Tandem Learning in Mathematics

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## Declaration of Competing Interest

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## Author contributions

All authors contributed to the study’s conception and design. Material preparation, data collection, and analysis were performed by Bor Bregant, Darjo Felda, and Daniel Doz. The first draft of the manuscript was written by Bor Bregant and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

## Data availability statement

The authors declare that the data supporting the findings of this study are publicly available. Dataset used is available at

<https://github.com/borbregant/ai_tandem_learning/blob/main/data_cleaned.xlsx>. Machine learning code is available at

<https://github.com/borbregant/ai_tandem_learning/blob/main/analiza_test.ipynb>. t-SNE visualization code is available at

https://github.com/borbregant/ai\_tandem\_learning/blob/main/t-SNE.ipynb.

## Abstract

Educational institutions aim to offer quality education, employing diverse teaching methods like tandem learning. Recognizing the need for personalized approaches, institutions should use data mining techniques to extract insights from educational datasets for optimal predictive model selection for individual students or classrooms. The aim of this study was to evaluate the performance of machine learning (ML) algorithms for predicting student response to tandem learning.

A dataset comprising 89 high school students and 13 predictor variables was utilized. The focus was on a three-state variable that determined whether the student positively responded to the integration of tandem learning into the educational environment. Nine classification ML algorithms were implemented and the 5 by 2-fold cross-validation with stratified folds was utilized.

Using all predictor variables, Random Forest and K-Nearest Neighbors performed the best, having accuracies of 0.55, and 0.53, and macro F1 scores 0.37, and 0.36 respectively, which is fair considering data balance. Balancing the dataset and using only 2 outcome classes, the performance improved, with the best algorithm being Gradient boosting, performing moderately well (accuracy = 0.59; F1-score = 0.59).

The results imply that machine learning algorithms struggle to accurately predict students' responses to group learning in mathematics using the variables and sample size employed. As a result, they may not be appropriate for aiding teachers in making decisions about selecting teaching methods. Therefore, a simplified approach can yield more effective results, in our case from the transformation of the machine learning classification problem from three states to two.

### Keywords

Assessment, mathematics education, machine learning, tandem learning, teaching methods

### Math subject classification, MSC2020

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